

ON THE SEXUAL AND RACIAL CHARACTERS OF THE HUMAN ILIUM

By D. E. DERRY, M.B., CH.B.,
Professor of Anatomy, Medical School, Cairo

THE work upon which this paper is based was undertaken in the first instance with the idea of showing that certain characters of the human ilium visible to the eye and of value to the anatomist, as aids in sexing the bone, might also be measured, and so be of interest to the statistician. But as the work proceeded it became evident that the influence of race had such an important bearing on the question that it was impossible to ignore it. In the following account which deals with measurements on the English hip-bones from the Whitechapel plague pits as well as bones from different periods in Egypt, and certain hip-bones from Dr Geo. Reisner's excavations at Kerma in the Sudan, the various groups mentioned are dealt with separately.

The results of the measurements obtained from the ilium justify us in considering this portion of the hip-bone to be of great sexual importance, while the racial factor appears to be of sufficient influence to necessitate the rigid separation of the different groups.

At the outset a word must be said with regard to the sexing of the material.

All the bones were sexed by means of the various features which experience has shown to be of the most value, and *before* any measurements were made. Objection has been taken to the fact that as we are measuring and comparing the very characters which we have previously employed as indicative of sex, and having segregated the bones according to these characters, we should naturally find them emphasised in the measurements. This is fair criticism and it follows that the only absolutely exact method of carrying out such an investigation would be to employ only those bones which have been taken from bodies of known sex. However no series such as Wingate Todd has collected is accessible to me, consequently we must either accept the anatomical verdict of sex for the great majority of the bones employed, or lose a large amount of material the sex of which can never be known with absolute certainty.

Most of the bones measured for the present work came under the latter category, but a few pelves were obtained from mummies in which the sex was known either from names on the tombs or coffins, or from the preservation of the organs. In none of these, when the hip-bones themselves came to be examined, were the features chosen as characteristic of sex falsified, and the series forms therefore a valuable corroboration of the correctness of the methods employed in sexing. Nevertheless, as already stated above, none of

the measurements presently to be detailed, were employed in sexing the bones, this being done entirely by ocular appreciation of all the characters concerned. This is an easier task in the case of the hip-bone than in that of any other bone in the skeleton, because sexual function in the woman has impressed upon the bone features, which if not absolutely peculiar, are so much more pronounced in her sex, as to leave no doubt in the great majority of cases, concerning the sex of the individual to whom the bone belonged.

In comparing typical male and female hip-bones it will be noticed that the great sciatic notch, or ilio-sciatic notch as it is better termed, differs markedly in the two sexes. In the man (fig. 1) the margins of the notch enclose a relatively deep and narrow excavation; in the woman (fig. 2) the posterior margin slopes backwards in such a way as to form a wide shallow arch in

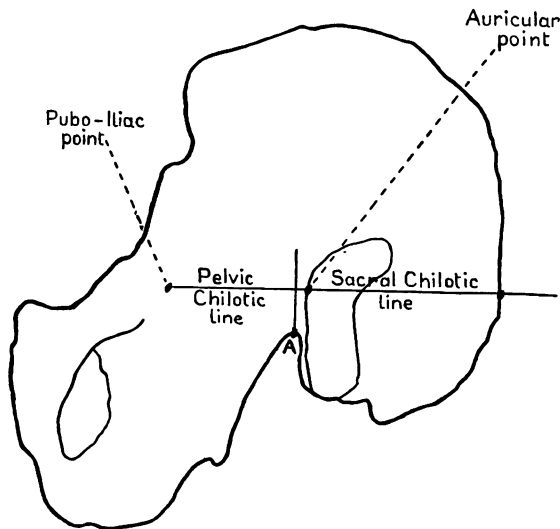


Fig. 1

striking contrast to that in the male. This difference in shape is associated with a difference in the position of the articular surface for the sacrum, and therefore of the sacrum itself, such that it stands further back in the pelvic cavity in the woman thus increasing the antero-posterior diameter of the pelvis. This implies a greater length of the iliac part of the ilio-pectineal line in women, and in conjunction with this there is a lessening in the extent of the rough area behind the auricular surface. These are well-recognised sexual characters and it remains to select suitable points from which to measure them.

For this purpose two points are chosen. The first is situated on the ilio-pectineal line at the site of the original union of the os pubis and ilium, and may be called the *pubo-iliac point* (fig. 1); the second is on the anterior margin of the auricular articular surface where this approaches nearest to the pubo-iliac point, and is termed in the present paper the *auricular point*. As the

correct identification of the pubo-iliac point in every hip-bone to be measured is essential for an accurate comparison of the characters under consideration, a more detailed explanation of the method employed in finding it is necessary.

Pubo-iliac point. In the large majority of adult hip-bones the original lines of union of the three constituent parts of the bone are obliterated, but a careful examination of hundreds of bones has shown that very fair accuracy may be obtained in identifying these lines if the following method is used:

The original lines of union of the ischium with the os pubis on the one hand, and with the ilium on the other are often faintly visible on the pelvic surface of the bone. These two lines meet at a point just below the ilio-pectineal line and the continuation from here of the old line of junction across the brim of the pelvis can frequently be detected. When this is the case a small dot should be marked with a pencil on the ilio-pectineal line at the point where it is crossed by the faintly-marked original line of union of the ilium and the os

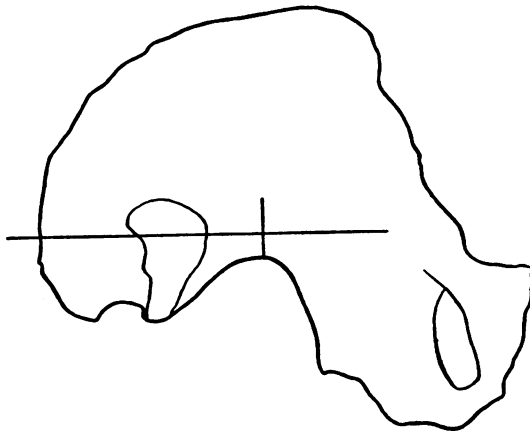


Fig. 2

pubis. If this is correctly done it will be found that the pencil mark is immediately opposite the deepest part of a depression in the acetabular rim. In many bones this notch in the rim is very pronounced and it also represents the place where the os pubis and ilium united. By this means therefore a double check on the true position of the pubo-iliac point is obtained. At times however it is impossible to detect any trace whatever of the line of union, and in such cases a line should be drawn from the notch in the rim of the acetabulum at right angles to the axis of this part of the ilium, the pencil dot being placed on the ilio-pectineal line, where the latter is cut by the line from the acetabulum. A further guide to the line of union is found in the fact that the bone here is very slightly elevated, and if it is held up to the light on a level with the eyes, the faintly-marked eminence produced by the original junction of the os pubis and the ilium can usually be detected. When the pubo-iliac point has been marked on the bone, the point on the margin of the auricular surface where the latter approaches nearest to the pubo-iliac point can be

easily determined with dividers and the *auricular point* so found similarly indicated by a pencil dot.

All the measurements here recorded have been made from projection drawings of the bones after setting them up in the manner now to be described.

The instrument used for tracing the outline of each bone was Martin's projection apparatus. The hip-bone is laid on the board beneath the glass table and is then manipulated with the aid of a wedge introduced under the bone until the two points *pubo-iliac* and *auricular* are on exactly the same level. This is determined by means of a scribe, whose pointed turned down arm is adjusted over each pencil spot in turn until the two are found to be on precisely the same horizontal line. As soon as this is done the drawing can be made. The two points should be indicated first, and then the whole bone should be traced out. The tracing should include an outline of the sacral articular surface.

When the drawing is complete the two points already indicated are united by a line which is produced posteriorly until it crosses the iliac crest. This line in its anterior part corresponds fairly closely with the iliac portion of the ilio-pectineal line, and thus with the pelvic brim. For this reason the whole line from pubo-iliac point to the place where it crosses the iliac crest has been termed the *Chilotic line* from the Greek χείλος (a brim or lip). It consists of two main parts, an anterior or pelvic portion between pubo-iliac and auricular points, and a posterior or sacral portion extending from the last-named point to the iliac crest. For the sake of brevity these two portions of the Chilotic line will be called throughout this paper Pelvic Chilotic and Sacral Chilotic respectively (see fig. 1).

One more point of great importance must now be indicated on the drawing. This is the apex of the ilio-sciatic notch or more accurately that part of the ilio-sciatic arch which approaches nearest to the Chilotic line (see *A* in fig. 1). A pencil mark is made on the drawing at the required spot, and from this point a line is drawn upwards cutting the Pelvic Chilotic line at right angles (see fig. 1). This portion of the Chilotic line is therefore divided into *two segments*, anterior and posterior, lying on either side of the line drawn from the highest part of the ilio-sciatic notch.

MEASUREMENTS

The Chilotic line as a whole and the parts into which it has been divided as described above can now be measured. In the first place the length of the two main portions, pelvic and sacral, is found and the relation of Pelvic Chilotic to Sacral Chilotic line gives the *Chilotic Index* = $\frac{\text{Sacral Chilotic} \times 100}{\text{Pelvic Chilotic}}$.

When these two portions of the total Chilotic line are of equal length the Index will of course be 100, and this figure may be taken in a general way to represent the boundary line between the sexes, a *typical* female having an index below 100, a *typical* male being invariably above that figure.

As will be shown later on in this paper this broad generalisation has to be considerably modified for the women: but as the essence of the investigation turns on the fact that the Pelvic Chilotic line in women is not only actually greater than that in men, but also, in many cases in the female, greater in relation to the Sacral Chilotic portion, the introduction of the statement at this stage is justified.

The next step is to find the lengths of the two segments of the Pelvic Chilotic line. These are situated as already described on either side of the Vertical line drawn from the apex of the ilio-sciatic notch. The relation of these two measurements is expressed as follows:

$$\frac{\text{Posterior Segment of Pelvic Chilotic line} \times 100}{\text{Anterior Segment}}$$

= *Chorematic Index*, a term derived from the Greek word *χώρημα* (space, room) because the Index is a measure of the proximity or otherwise of the sacral articular surface, and therefore of the sacrum, to the ilio-sciatic notch, with a consequent alteration in the capacity of the true pelvis.

MATERIAL

It has already been mentioned that the measurements as just detailed have been carried out on the English hip-bones from Whitechapel now in the care of the Biometric Department at University College, London, but formerly belonging to Sir George Thane, to whom the thanks of the writer are due for the loan of this valuable material. In addition a number of hip-bones of the Vth–XIIth Egyptian Dynasties 2500–2000 B.C. have been measured as well as some from the Predynastic era and a few from Dr Geo. Reisner's excavations at Kerma in the Sudan¹. It is to be regretted that a number of measurements made on bones from the Collection of the Archaeological Survey of Nubia have had to be discarded owing to their mixed origin, and the smallness of the numbers that a separation into racial groups would entail.

CHILOTIC INDEX

The results obtained from the measurements may now be considered.

Table I. *Men*

Race	No.	Chilotic line		Total length	Chilotic Index	Pelvic Chilotic line		Chore-matic Index
		Pelvic portion	Sacral portion			Antr. segment	Postr. segment	
English ...	61	52.8	71.2	123.9	136.1	48.9	3.9	8.2
Vth–XIIth Dyn.	42	55.0	68.4	123.2	125.9	49.8	5.6	11.5
Predynastic ...	24	54.5	67.7	122.2	125.6	46.1	8.1	18.7
Kerma ...	19	55.5	68.4	123.9	125.2	45.8	9.8	21.8

¹ The Kerma crania which were measured by the writer in 1920 are almost identical with the Middle Nubian people described in the *Bulletins of the Archaeological Survey of Nubia*. The nasal measurements, however, indicate a greater infusion of negro blood than was found to be the case in the Middle Nubians. The negro influence is emphasised in the pelvic measurements.

As will be seen in the accompanying Table I, the *total length* of the Chilotic line in the men is practically identical in three out of the four groups examined. There is in fact no sensible difference in the actual size of the bone in these races. But a remarkable difference is apparent in the English men as compared with the other three groups when the Chilotic line is divided into its two component parts Pelvic and Sacral. In this case the English are found to have the shortest Pelvic Chilotic line (52·8) as against an average of 55·0 in the remaining groups, but they have at the same time the longest Sacral Chilotic line (71·2) so that the *Chilotic Index* for this race rises to 136·1.

Table II. *Women*

Race	No.	Chilotic line		Total length	Chilotic Index	Pelvic Chilotic line		Chore-matic Index
		Pelvic portion	Sacral portion			Antr. segment	Postr. segment	
English ...	34	55·7	61·3	117·0	110·8	44·8	10·9	24·7
VIth–XIIth Dyn.	32	62·9	56·5	119·5	90·7	46·5	16·5	36·1
Predynastic ...	42	59·0	63·1	122·3	107·1	46·3	12·6	27·8
Kerma (Nubian)	21	60·9	62·1	123·0	103·2	48·3	12·6	26·8

In the women (Table II) the *total length* of the Chilotic Line varies from 117·0 in the English to 123·0 in the Kerma group. But although the Pelvic portion of the line is again shorter in the English women than in the women of the other groups, in all of them it *exceeds* the length of the same line in the men of their respective races (see Table I). This is of course only another way of demonstrating the greater antero-posterior diameter of the pelvis in women. When, however, we come to examine the *Sacral Chilotic* line in this sex we find it to be consistently smaller than in the men, both actually as well as in relation to the total length, so that the Chilotic Index falls towards the figure already suggested as the boundary line between men and women, *i.e.* 100, and in the VIth–XIIth Dynasty Egyptian women reaches as low as 90·7. It is instructive to note, however, that as in the case of the English men, the Whitechapel women have the highest Chilotic Index. The significance of this will be discussed later.

CHOREMATIC INDEX

We may now examine the relation of the two segments of the Pelvic Chilotic line to each other. Beginning again with the English men (Table I), we find that the division of this line in the manner described above, yields a mean of only 3·9 mm. for the posterior segment. This means that the most anterior point on the margin of the sacral articular surface is only 3·9 mm. from the line drawn upwards from the highest part of the ilio-sciatic notch. The shortness of the Pelvic Chilotic line in the English men is thus explained, and is seen to be due to the advance of the sacrum which is nearer to the notch in this race than in any of the others measured. As a consequence the Chorematic Index is very low (8·2), and is approached only by the Old Empire Egyptians with an Index of 11·5. In the two remaining races the Chorematic

Index is relatively high, but in both of these the posterior segment of the Pelvic Chilotic line is more than double the length of that in the English owing to the sacrum standing further back from the notch, a condition which is associated with a more erect position of the sacrum and absence of the sacro-vertebral angle.

It should be noted that the race with the lowest Chorematic Index (8·2) has the highest Chilotic (136·1) and in general it may be said that these two Indices stand in inverse ratio to one another.

In the women the *Chorematic Index* is in marked contrast to that in the men. Although the English women are the lowest of the four female groups in this regard, their Index (24·7) is nevertheless three times as large as the Chorematic Index in English men. The explanation is the same as that given above for the men, and is due to the posterior segment of the Pelvic Chilotic line being so much longer in women than in men. Fig. 2 shows an outline of a female hip-bone in which the sacral articular surface is well removed from the vertical line (cf. Fig. 1). This is the typical female condition and all the groups illustrate it, but none so well as the Egyptian women of the Old Empire in whom the Chorematic Index rises to 36·1, as compared with 11·5 in the men of the same period. Here again too we find that the highest Chorematic Index is associated in the same race with the lowest Chilotic Index 90·7.

In the two remaining female groups, Predynastic and Kerma, the Chorematic Index, although high, does not exhibit the remarkable contrast to the men of their own race which is illustrated in the two higher races. In these two primitive groups there is a tendency towards greater similarity between the sexes in this regard, thus confirming by measurement, what had been encountered in sexing these hip-bones by the ordinary anatomical methods, viz. that sexual differences in primitive races are less marked than in the higher races. This is brought out in the Tables I and II, where the lengths of the posterior segment of the Pelvic Chilotic line in the two sexes of the Predynastic and Kerma groups, are much nearer to one another than in the English and Old Empire Egyptians with a resulting similarity in the Chorematic Index.

We may now consider in more detail the meaning of the remarkable differences which we have found to exist, as between the sexes, in this (iliac) part of the hip-bone. For this purpose it is necessary in the first place to examine the same region in some of the lower animals. We have seen that the essential difference in the human ilium between men and women is in the position of the sacral articular surface, which by its greater or less distance from the line drawn upwards from the apex of the ilio-sciatic notch, increases or lessens the posterior segment of the Pelvic Chilotic line. The position of the articular surface is of course the position of the sacrum and accordingly the antero-posterior diameter of the pelvis varies with it. Now in most of the lower animals this antero-posterior diameter is very long, the sacrum standing far back from the symphysis pubis, while the ilio-sciatic notch, which is such

a well-marked feature of the human hip-bone, is non-existent as a notch, and is represented only by a shallow excavation of the ilio-sciatic border. This is the condition with very slight variations in practically all the Mammalia. In the Apes (Fig. 3) we begin to find indications of a notch and this is due to a

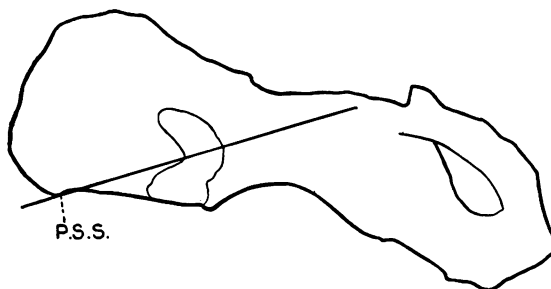


Fig. 3

slight downward bending of the ilium in the neighbourhood of the sacral articular surface. The hip-bones of the Anthropoid-Apes furnish a good illustration of this commencing notch which only reaches its characteristic form in man. That this is directly related to his erect carriage, seems to be the natural corollary.

This conclusion is borne out by the following facts. The posterior superior iliac spine in man is approximately at the level of the spinous process of the second Sacral Vertebra and is only removed from the posterior inferior spine by a very short interval. The last-named "spine" is really the lower end of the sacral articular surface. Now if we examine the corresponding points in a baboon we find that the posterior superior spine lies altogether above the

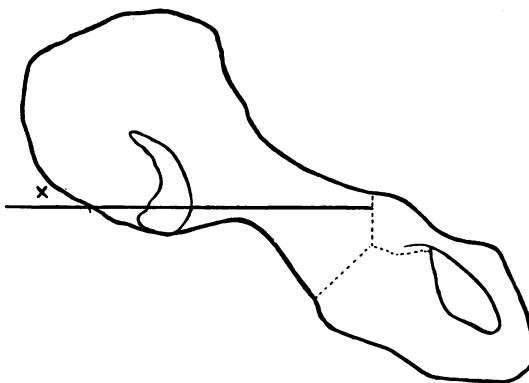


Fig. 4

level of the sacral spines, on a level with the lower border of spine of last lumbar and is separated from the posterior inferior spine by a long straight border. This is strikingly demonstrated, if the hip-bone of this ape (Fig. 3) or of the orang (Fig. 4) is treated in the manner described in this paper for the

human bone. In such a case when the Chilotic line is drawn through the two points pubo-iliac and auricular and produced backwards to cut the iliac crest, it is found to pass *not* through the crest and *above* the posterior superior spine as in man, but *below* it, between posterior superior and inferior spines (see Figs. 3 and 4). The posterior superior spine as well as the posterior part of the ilium, must therefore have been dragged down in the human being in the process of walking erect and this has brought the sacrum down with it. But another influence has also been at work, viz. the body weight. This acting on the base of the sacrum has forced that bone forwards, so that while the sacrum as a whole has descended lower into the pelvic cavity by reason of the pulling down of the ilium, it has also moved towards the symphysis. Now the amount of this forward movement is measured, as we have seen, by the length of the posterior segment of the Pelvic Chilotic line, and this is short in the men and long in the women. But of the four racial groups, the English of both sexes

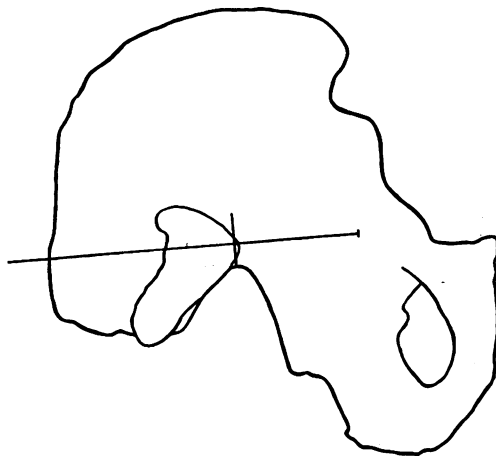


Fig. 5

exhibit the greatest amount of forward movement. This is most marked in the men, so that the mean length of the posterior segment of the Pelvic Chilotic line is reduced in this sex to only 3·9, while in five cases out of 61 this forward movement has been carried so far that the anterior margin of the sacral articular surface actually overlaps the line drawn from the top of the ilio-sciatic notch, thus reducing the posterior segment of the Pelvic Chilotic line to a minus quantity (see Fig. 5). This was never met with in any female bone measured.

In the hip-bones of the Egyptian men of the Vth–XIIth Dynasties much the same state of affairs exists. The posterior segment of the Pelvic Chilotic line is short (5·6) and there is an even larger percentage of cases where this line is reduced to minus. In the Predynastic Egyptians, and still more in the Kerma people, the posterior segment of the Pelvic Chilotic line is very definitely longer with a consequent rise in the Chorematic Index. In other words the

sacrum has not moved forward to the same extent as in the two higher races. For this reason, as mentioned above, there is greater similarity between the sexes in these more primitive people, while at the same time the smaller forward movement of the sacrum accounts for the greater frequency of the dolichopellic type of pelvis in primitive races.

In this connection it should be noted that the more upright position of the sacrum in the negro races is associated with a reduction in, or even complete absence of, the lumbar convexity. In these people the sacro-vertebral angle scarcely exists, and the antero-posterior diameter of the pelvis is therefore relatively long, thus recalling the shape of the pelvis in the apes. This is in marked contrast to the pronounced angle and prominent lumbar curve in such a race as the English, in whom, as has been shown, the antero-posterior diameter is shorter than in any of the racial groups examined in the course of this investigation.

Is it possible to give any explanation of these striking sexual and racial differences?

Some light seems to be thrown on the subject by the following facts. (a) In cases of rickety pelvis in women the impediment to normal labour is the reduction in the antero-posterior diameter or conjugate owing to the pushing downwards and forwards of the sacrum, by the body weight acting on abnormally soft bones. In these cases the hip-bones are of an exaggerated male type in regard to the ilio-sciatic notch and the backward bending of the ilium. (b) In an oblique pelvis in a woman due to congenital fusion of the right sacro-iliac joint with consequent lack of development of the ala of the sacrum on the same side, the affected side developed a typical masculine ilio-sciatic notch, while on the left or normal side the notch was characteristically female. (c) It is not uncommon to find bones from opposite sides of the same pelvis unequally developed. One of the Predynastic Egyptian pelvises measured in the course of the present investigation gave a Chilotic Index of 109·3 for the right side (Fig. 6) and 92·7 for the left (Fig. 7). The Chorematic Index for the two sides was 6·3 and 18·1 respectively. An examination of the complete pelvis showed that the first piece of the sacrum, although normal on the right side was only partially sacralised on the left. The left hip-bone resembled the female type in being less heavily built, this being specially noticeable in the iliac crest, ischial tuberosity and body of ischium. Whether this striking asymmetry is due to lack of development of the left side of the sacrum, or whether the under-development of the whole left side of this pelvis, including the sacral anomaly, was brought about by feebleness of muscular development, as for instance in cases of paralysis while the bones are still growing, cannot be stated, but the fact remains that the more robust side developed as a normal male pelvis, while the weaker left has a majority of female characters. (d) Obstetricians not infrequently find that women of masculine build have difficulty in labour. This is in agreement with anatomical observation, where heavily built female pelvises are found to resemble the male type.

The results given above in the table of measurements for the women, show that the English women have the smallest pelves at least in the antero-posterior diameter. They are therefore less typically female than is the case in Egyptian women generally, and particularly so when compared with the women of the

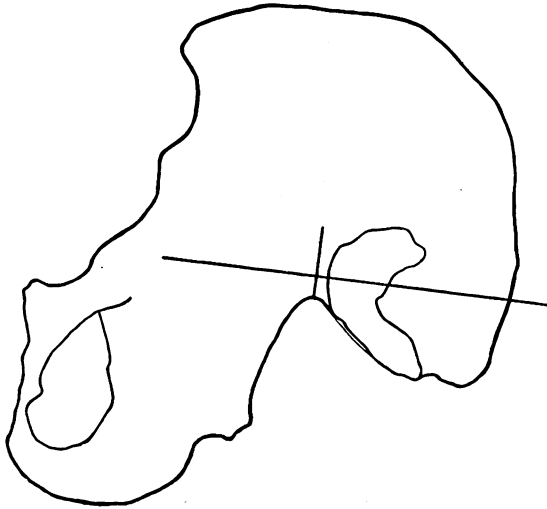


Fig. 6

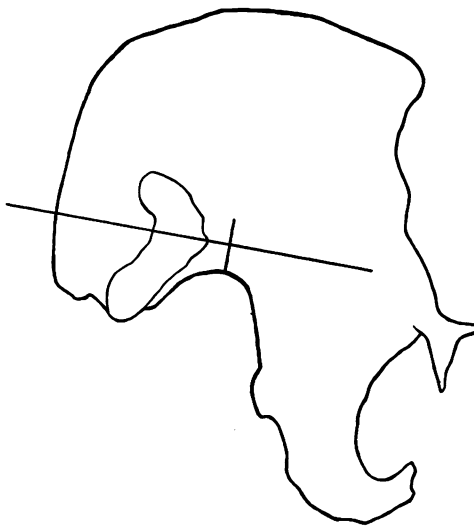


Fig. 7

Vith-XIIth Dynasties. A large antero-posterior diameter is of greater importance for an easy labour than a large transverse and the reduction of this in English women is possibly a cause of the difficulty in parturition which is so common an experience in England as compared with Egypt.

Now the evidence from the facts just adduced appears to point in the direction of weight as an important factor in the production of the male type of pelvis. This is certainly so in the case of the rickety pelvis. In the oblique pelvis instanced, the weight was unevenly distributed owing to the failure of development of one side of the sacrum, and the same may have been true in the pelvis exhibiting male and female characters on opposite sides, owing to the unequal development of the first piece of the sacrum. In the pelvis of a man with hydrocephalus described by the writer in this Journal, vol. XLVII, July, 1913, the left hip-bone in common with all the bones of the left side was under-developed owing to hemiplegia. Here again the ilio-sciatic notch was definitely wider on the left side, and the same bone exhibited a tendency to the formation of a pre-auricular sulcus, a female character. In this man the body weight was borne entirely on the right side, the pelvis was tilted to the left and the left ala of the sacrum was under-developed.

Although the facts adduced above seem to point to body weight as an important factor in the production of the different forms of the ilium in the two sexes, the evidence obtained from foetal bones measured in the same way is much less conclusive.

The following table gives the results of measurements made on four foetuses, two male and two female. All were full time with the exception of the second male in the annexed table, which was believed to be seven months when born.

Table III. *Foetuses*

Sex	Chilotic line		Total length	Chilotic Index	Pelvic Chilotic line		Chore-matic Index
	Pelvic portion	Sacral portion			Antr. segment	Postr. segment	
Male	16.0	26.0	42.0	162.5	15.0	1.0	6.6
Male	13.5	17.5	31.0	129.6	13.0	0.5	3.8
Female	17.5	22.0	39.5	125.8	15.5	2.0	12.9
Female	18.0	21.5	39.5	119.4	16.0	2.0	12.5

While too much stress must not be laid on figures derived from such a small number of cases, it will be noticed that all the foetal hip-bones, irrespective of sex, yield the male type of *Chilotic Index*, but the two females are the lowest. In other words the characteristic difference, in the female, in the relation of the two portions of the Chilotic line, Pelvic and Sacral, though not pronounced at this early date is nevertheless suggested. At the same time the relation of the two segments of the Pelvic Chilotic line exhibited in the *Chorematic Index* also shows a definitely higher value in favour of the two females.

As there is no question here of the influence of the erect posture or of body weight, there must be an inherent tendency towards the formation of a sexual type, which as growth proceeds becomes more pronounced, from the influence of body weight, muscular development, and probably in the case of the woman, function, as represented by child-bearing.

In 1913 Dr Franz Weidenreich published in the *Anatomischer Anzeig.*, Nos.

20 and 21, the results of his investigations, "Über das Hüftbein und das Becken der Primaten und ihre Umformung durch den aufrechten gang." He approached the subject from a somewhat different point of view to that contained in this paper, as he was concerned with the measurement of the angles formed by the axes of the three constituent parts of the hip-bone, using the centre of the acetabulum as his point of departure. Nevertheless he reached substantially the same results in regard to the descent of the ilium in the higher apes and notably in man.

Although the figures dealt with in this communication refer only to the ilium, it is probable that an exhaustive series of measurements of the whole hip-bone would reveal a number of further points of value in determining the sex of a given individual. The work of Dr Weidenreich referred to above points strongly in this direction. But in order to do this satisfactorily it is necessary in the first place to increase the number of bones whose sex is definitely known.

Dr Aziz Girgis, Lecturer in Anatomy, and Dr B. Boulgakow, Curator of the Anatomical Museum, have rendered willing assistance in the photographing and preparation of the drawings, and grateful thanks are due to all those engaged in archaeological work in Egypt who have supplied the writer with material.